Predicting Risk from Radon in Source Waters from Water Quality Parameters

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Background

Where does radon come from?

Affiliations:

 Rn-222 is an alpha-emitting intermediate in the U-238 decay series

U-238 $\rightarrow \rightarrow \rightarrow$ U-234 $\rightarrow \rightarrow$ Ra-226 \rightarrow Rn-222 α & β α α \rightarrow Po-218 $\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$ Pb-206 α α & β stable

- · Associated with granitic formations
- Higher radon concentrations in smaller groundwater systems

Radon in drinking water

- Not currently regulated in drinking water
- Drinking water is a largely overlooked source
- Sporadic occurrence data has been gathered
- Transfer factor from water to air: 10,000:1
- Recognized that radon in water presents a higher cancer risk than other regulated chemicals

Exposure pathways



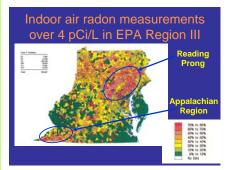
Overall lifetime unit risk from radon in drinking wate 6.7 X 10⁻⁷ per pCi/L in wate

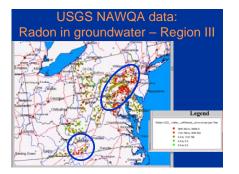
11% of risk Endpoint: stomach cance

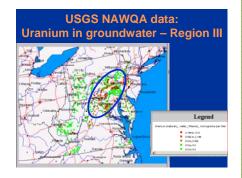
Region III radon case studies

- Chesdin Manor (VA) 17,000 pCi/L in finished water
 - Uranium also present at levels over MCL
 - Combined (inhalation + ingestion) risk from drinking water alone: 1 X 10⁻²
- Glen Alsace (PA) 70,000 pCi/L in finished water
 - -Combined risk: 5 X 10-2
 - -Contribution to indoor air: 7 pCi/L

Occurrence Information







Study Approach and Expected Benefits

Research objectives

- Gather targeted occurrence data
- Correlate radon concentrations with:
 Concentrations of other radionuclides
 - Other water chemistry parameters
 - Well characteristics
- Geology of area
- Model developmentModel validation

Study approach

- Focus on small community groundwater systems
- Partner with states to sample raw water for water chemistry parameters, radon, uranium-238, and other radionuclides
- Gather information on well characteristics
- Develop model to correlate radon concentrations with other parameters
- Validate model by testing against additional groundwater systems

Model inputs

- Water chemistry
 - -pH, T, TDS, DO, alkalinity, ORP, specific conductivity
 - -SO₄²⁻, Ca²⁺, Mg²⁺, Na⁺, Cl⁻, Si, Ba²⁺
 - -Rn-222, U-238, Ra-226, Po-210
- Well characteristics
 - Well depth, depth to water table, pumping rate, hydraulic conductivity

Expected results and benefits

- Predictive tool
- Protective measures can be implemented in advance of a regulation
- Increased awareness of radon contributions from drinking water
- Collaboration between state drinking water and radiological health programs
- Targeting resources where most needed

